Investigation into the biomechanical properties of cancellous bone preserved using Thiel's fixation method

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Thiel's method is a new anatomical fixation technique that has shown to have a combination of traditional durability of tissues but combined with a realistic flexibility, particularly in the musculoskeletal system. Thiel's method is particularly suited to clinical applications where life-like model validation and biomechanical testing of cadaveric tissue is required. Unlike formalin-fixation, Thiel's fluid contains boric acid which, in addition to its disinfectant properties, partially denatures the collagen in muscles and tendons, resulting in a more flexible anatomical specimen. The aim of this study is to biomechanically test sections of Thiel preserved cancellous bone relating to the head and neck of human femora and to obtain its Young's modulus and yield strength. Cancellous bone from left and right proximal femora was obtained from two human cadavers* – one preserved using traditional formalin-fixation and the other using Thiel's method. Left and right femora were harvested and sectioned into 12 equal segments, from proximal to distal. Sections 1-3 were used in this study and relate to the head, neck and trochanter's of each femur. Cancellous bone was excised and immersed in a 10% SDS solution for 48 hours at 4°C to remove excess bone marrow, then repeatedly washed in 10% PBS solution. $10mm^3$ segments were cut (n=14 for the Thiel and n=11 for formalin) and subjected to mechanical testing using a compress to yield protocol with a 2500N load cell. Yield strength (MPa) and modulus (MPa) were significantly correlated in both samples [formalin group = 0.91 ($\leq$0.001) while Thiel group = 0.718 ($\leq$0.0038)]. RMA regression analysis, however, revealed significant differences in the scaling of Young's modulus with stress at yield (<0.001) between Thiel and formalin fixed specimens. This highlights that the biomechanical properties of Thiel-fixed cancellous bone are significantly different from formalin-fixed cancellous bone. This could have future implications in the biomechanical use of Thiel preserved cadavers where a life-like model validation is required. * Full consent was obtained according to HTA guidelines